

A NEW GENUS AND SPECIES OF CYLAPINAE FROM
NEW CALEDONIA WITH RE-ANALYSIS OF THE *VANNIUS*
COMPLEX PHYLOGENY (HETEROPTERA: MIRIDAE)

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A remarkable new genus and species of cylapine plant bug, *Kauakamiris krypton* (Insecta: Heteroptera: Miridae), are described from New Caledonia. The male and female genitalia are described and illustrated. The generic phylogeny of Cassis, Schwartz, and Moulds (2003) is re-analysed to include the new taxon, with additions and corrections, and a new sister-group relationship is established. The distribution of *Kauakamiris* is discussed in relation to theories on New Caledonia harbouring basal taxa. Its biology as a probable mycetophage is discussed. □ *Systematics, Miridae, Cylapinae, Vannius complex, Kauakamiris krypton, mycetophagy, New Caledonia, phylogeny, biogeography.*

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The Cylapinae is a poorly studied subfamily of the speciose family Miridae (Insecta: Heteroptera). The classification, biogeography, and biology of this largely cryptozoic subfamily of plant bugs are little known (Schuh & Slater, 1995; Wheeler, 2000). Most biological information comes from label data, with many species found on the ground, in litter, under bark, or associated with mycelia or fruiting bodies of higher fungi (Wheeler, 2000; Cassis & Gross, 1995). Information on their feeding habits is limited, with generalisations about cylapine behaviour being based on just a handful of observations. Much has been made of their frequent occurrence in fungus-laden places, resulting in proposals of fungivory which, nevertheless, are supported by few direct observations (e.g. Schuh, 1976). Wheeler (2000) synthesised existing information on cylapine biology, suggesting that some Fulviini are predaceous. The undoubted basal position of the Cylapinae within the Miridae (Schuh, 1975, 1976) implies relictual distributions and plesiomorphic food-preferences.

The Cylapinae, although not greatly rich in species, particularly in comparison with the more diverse and largely arboreal subfamilies (Mirinae, Orthotylinac and Phylinae), is notably cosmopolitan, with greatest diversity in the Southern Hemisphere. Gorczyca (2000) reviewed the Afrotropical fauna, nearly doubling the species diversity for that region. In contrast, the Cylapinae of the Australian zoogeographic

region are poorly documented. Cassis & Gross (1995) listed only 14 species from the Australian continent, but the diversity of unstudied cylapines in collections reveals a much richer fauna.

New Caledonia has been recognised as a biodiversity hotspot of global significance (Mittermeier et al., 2004), formerly sub-contiguous with Australia. Furthermore, many biotic elements of New Caledonia are ancient, and probably relictual; e.g. the flora includes diverse gymnosperms and many plesiomorphic angiosperm genera (Jaffré et al., 2001). Numerous New Caledonian taxa of Hemiptera are also probably relictual in distribution, e.g. *Notuchus* Fennah (Delphacidae; Donaldson, 1988), *Sagmation* Hamilton (Cicadellidae; Hamilton, 1999), *Oiophysella* Evans (Peloriidae; Evans, 1982), *Monteithostolus* Štys (Enicocephalidae; Štys, 1981), *Schizopteromiris* Schuh (Miridae; Schuh, 1986), Targaremini (Rhyparochromidae; Distant, 1920) and *Gnostocoris* Kormilev (Aradidae; Monteith, 1980).

Queensland Museum entomologists have undertaken several expeditions to the main island (Grande Terre) of New Caledonia since 2000. These have revealed a species-rich and highly insular arthropod fauna, which is still poorly described. This includes a substantial cylapine fauna, belonging to both the Fulviini and the *Vannius* complex of the Cylapini. Prior to these modern collections, the only member of the latter suprageneric group recorded from New

Caledonia was *Vanniopsis rufescens* Poppius 1909. Cassis et al. (2003) reviewed the *Vannius* complex from the Australian Region and recorded a new genus, *Austrovannius*, from New Caledonia and Australia. It has numerous narrowly distributed species in New Caledonia, mostly from montane rainforest habitats, and most in preparation for publication. In addition, a remarkable and highly autapomorphic species of the *Vannius* complex that does not fit any existing genus, has been found in these collections. The aim of this paper is to describe this taxon and to reassess the generic phylogeny of the *Vannius* complex proposed by Cassis et al. (2003), including significant additions and corrections.

The fourth genus of the *Vannius* complex known in the Australian Region is *Vanniusoides* Carvalho & Lorenzato, recorded from Fiji, Solomons, New Guinea and Queensland by Cassis et al. (2003). There are specimens of this genus in the Queensland Museum from the southern extremity of New Caledonia (unpubl.). This means that the island has all four genera, the only land mass in the world with this level of generic diversity.

MATERIALS AND METHODS

This study is based on 34 Queensland Museum specimens. The holotype is deposited in the Muséum National d'Histoire Naturelle, Paris (MNHN). Paratypes are deposited in the Queensland Museum, Brisbane (QM) and the Australian Museum, Sydney (AM).

Morphological terminology follows that given by Cassis (1995) and references therein. Terminology for the male genitalia does not follow that given by Kerzhner and Konstantinov (1999), such that the subdivision of the endosoma into conjunctiva and vesica is regarded as debatable. Light microscope observations were made using a Leica MZ16 stereomicroscope and a Leica DMB compound microscope.

Scanning electron micrographs were prepared with a Cambridge scanning electron microscope using techniques outlined in Bolte (1996) and Swearingen et al. (1997).

For the phylogenetic analysis, the data were assembled using MacClade 4.03 (Maddison & Maddison, 2001) and analysed using PAUP* version 4.0b10 (Swofford, 2002). Exhaustive searches were made using unweighted, successive weighted (reseeded consistency index), and implied weights (Goloboff fit criterion $K=2$).

The same outgroups used in Cassis et al. (2003) were used in this analysis (*Bothriomiris lugubris* Poppius, *Peritropis bituberculata* Carvalho & Lorenzato and a species of *Cylapocerus* Carvalho). Multistate characters were coded as unordered. Nodal support was calculated using bootstrap resampling with 1000 replicates.

SYSTEMATICS

Kanakamiris gen. nov.

ETYMOLOGY. The genus refers to a local name for the indigenous peoples of New Caledonia – the *kanaks*, combined with the standard root from the family name – *miris*.

TYPE SPECIES. *Kanakamiris krypton* sp. nov., here designated.

DIAGNOSIS. The genus is recognised by the following attributes: elongate, macropterous (Fig. 1); head porrect, ant-like (Fig. 2A); vertex with longitudinal sulcus (Fig. 2A); bicompressed, sub-elliptoid labrum (Fig. 2B); compressed gula, with ridge-like midline (Fig. 2B); labium short, L1 surpassing bucculae; AI elongate, AII banded, AIII and AIV threadlike (Fig. 1); eyes enlarged, contiguous with anterior margin of pronotal collar (Figs 1, 2A); pronotum campanulate (Figs 1, 2C); pronotal collar enlarged, raised (Figs 1, 2C); scutellum medially tumose (Fig. 1); R+M and median flexion line contiguous (Fig. 1); elaval commissure elongate (Fig. 1); cuneus narrow (Fig. 1); external efferent system of metathoracic glands well developed (Fig. 2D); peritreme anterior in orientation (Fig. 2D); metathoracic spiracle visible (Fig. 2D); tarsi two-segmented; genital opening of male pygophore dorsal in orientation (Fig. 3A); parameres simple, weakly arcuate (Figs 3B-C); aedeagus sac-like with three ribbon-like basal processes (Figs 3D-E); secondary gonopore ring-like, prominent, with distal duct (Fig. 3D).

DESCRIPTION. Structure: Macropterous males (Fig. 1) and females; body elongate. Head: ant-like, porrect, greatly elongate, longer than wide (Fig. 2A); moderately declivent (Fig. 2B); vertex narrow, with weak, shallow medial sulcation (Fig. 2A); frons conical, convex in profile (Figs 2A-B); clypeus short, conical, coplanar with frons (Fig. 2B); mandibular plate large, subtriangular (Fig. 2B); bucculae very short, margins rounded (Fig. 2B); labrum enlarged, greatly bicompressed, subelliptoid, platelike (Fig. 2B); gula strongly bicompressed, with medial impressed margin (Fig.



FIG. 1. *Kanakamiris krypton* gen. et sp. nov., dorsal view of male. Illustration by Geoff Thompson.

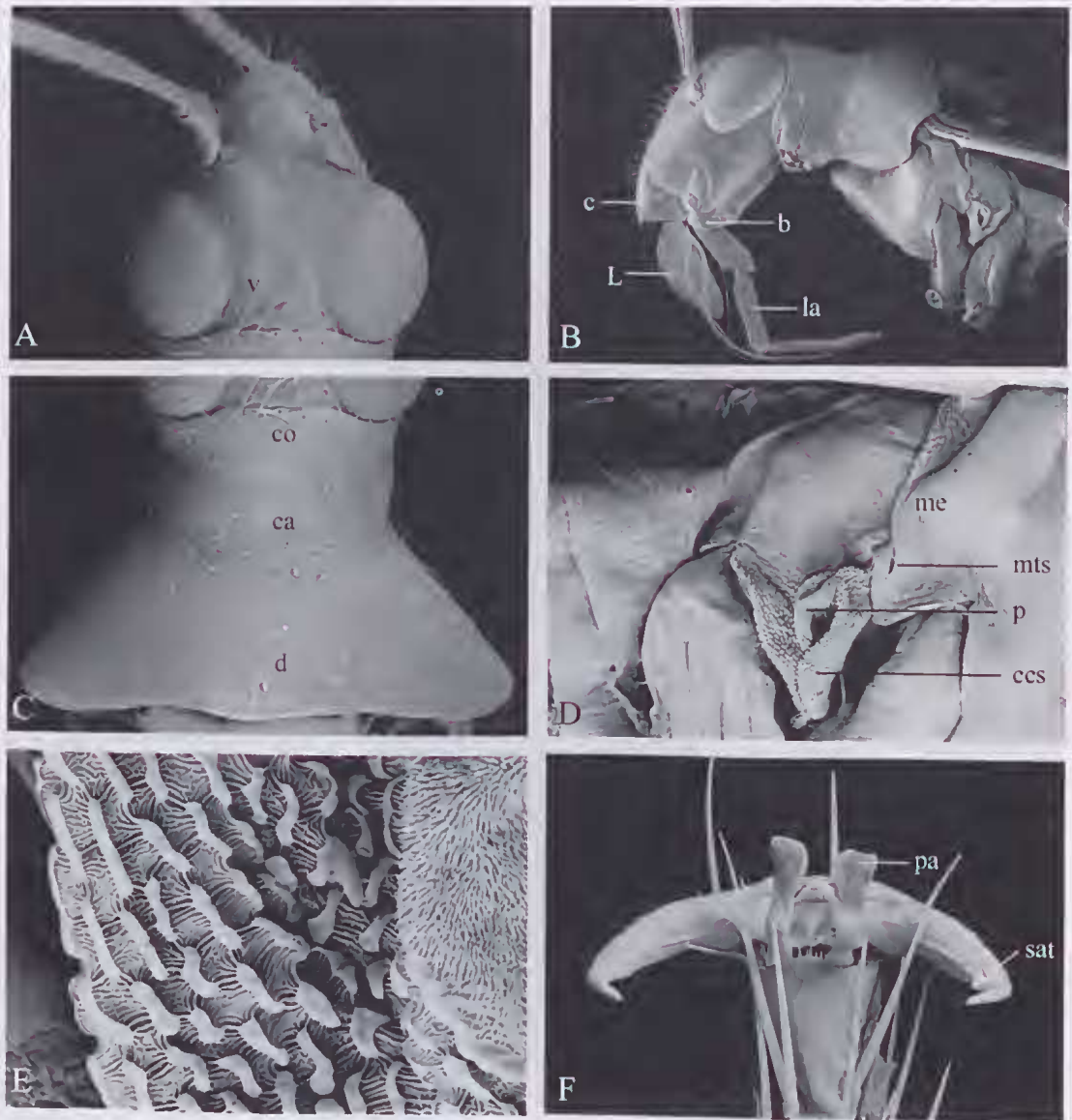


FIG. 2. *Kanakamiris krypton* gen. et sp. nov., external morphology. A, head, dorsal view; B, head and thorax, lateral view; C, pronotum, dorsal view; D, thoracic pleura, lateral view; E, evaporative areas of metathoracic glands; F, pretarsus, ventral view. Abbreviations: b, bucculae; c, clypeus; ca, callositic region of pronotum; co, pronotal collar; d, discal region of pronotum; ees, external efferent system; L, labrum; la, labium; me, mesepimeron; mts, metathoracic spiracle; p, peritreme of external efferent system; pa, parempodium; sat, subapical tubercle; v, vertex.

2B); labium thick, relatively short, reaching apices of mesocoxae (Fig. 2B); LI short, just surpassing bucculae posteriorly; eyes greatly enlarged, mostly dorsally oriented, contiguous with anterior margin of pronotal collar (Figs 1, 2A-B). Antennae: relatively thin and elongate, with AIII and AIV threadlike; AI elongate, narrowly

vasiform, longer than interocular distance; All weakly expanded distally, a little longer than posterior width of pronotum (Fig. 1). Pronotum: campanulate, lateral margins strongly expanded posteriorly (Figs 1, 2C); collar greatly enlarged, rounded, raised above callositic region (Figs 1, 2C); disc moderately rounded; posterior



FIG. 3. *Kanakamiris krypton* gen. et sp. nov., male genitalia. A, male pygophore, dorsal view; B, right paramere, lateral view; C, left paramere, lateral view; D, aedeagus, lateral view; E, apex of endosoma, ventral view. Abbreviations: bs, basal sclerite; ds, ductus seminis; go, genital opening of male pygophore; sg, secondary gonopore.

margin of disc weakly bisinuate (Figs 1, 2C). Mesoseutum: exposed, moderately convex (Fig. 1). Scutellum: medially tumose, laterally flattened (Fig. 1). Mesepimeron: moderately developed, metathoracic spiracle visible, with evaporative areas on postalar margin (Fig. 2D). Metathoracic glands: external efferent system well developed, occupying more than $\frac{1}{3}$ of metepisternum, reaching mesepimeron in lateral view (Fig. 2D); peritreme anteriorly oriented, tongue-like (Fig. 2D); evaporative bodies with elongate caps (Fig. 2E). Legs: elongate, linear; tarsi two-segmented, both segments elongate; parempodia flattened, spatulate-like (Fig. 2F). Hemelytra (Fig. 1): elavus prominent, commissure longer than anteromedial margin of clavus; median flexion line elongate, reaching midpoint of elaval commissure, partly contiguous with R+M vein; euneus elongate, narrow; two membrane cells present, minor cell very narrow, elongate. Male genitalia: genital opening of male pygophore dorsal in orientation (Fig. 3A), suboval; parameres roughly equal in size; right paramere, smaller than left, weakly arcuate, tapered distally (Fig. 3B); left paramere weakly arcuate, with flange near base of shaft, tapered distally (Fig. 3C); aedeagus sae-like with three ribbon-like basal processes; apex of one membranous lobe with sclerotised, serrate margin (Figs 3D-E); secondary gonopore ring-like, prominent, with attached, distal duct (Fig. 3D); ductus seminis short, heavily sclerotised, without hose-like substructure (Fig. 3D). Female genitalia (Fig. 4): dorsal labiate plate with simple, symmetrical, sclerotised rings; dorsal surface of common oviduct granulate; posterior wall of bursa copulatrix simple, obscurely bilobed, with dorsal and lateral margins of inter-ramal sclerites sclerotised; without inter-ramal lobes.

REMARKS. This genus is distinct amongst the *Vannius* complex in possessing the highly autapomorphic head (head porrect, ant-like; bicompressed labrum; pinched gula). The body has disruptive colouration patterning more reminiscent of that found in species of *Vanniusoides* and *Vannius*, than the spotted appearance of *Austrovannius* species. However, *Austrovannius* and *Kanakamiris* share the presence of a ring-like secondary gonopore.

Kanakamiris krypton sp. nov.
(Figs 1-4)

ETYMOLOGY. This species is named after its cryptozoic habitus; from the Greek *kryptos*, meaning hidden.

MATERIAL. NEW CALEDONIA, PROVINCE NORD: HOLOTYPE ♂, 21°09'S × 165°19'E, Aoupinié sawmill, 500m, 2.i.2005, G.B. Monteith, beating, rainforest, [11984] (MNHN); PARATYPES. NEW CALEDONIA, PROVINCE NORD: 2♂1♀, same data as holotype (AM); 3♀, 20°58'S, 165°17'E, Pic d'Amoa, N. slopes, 500m, 10-24.xi.2001, C.J. Burwell & G.B. Monteith, malaise trap, [8683] (AM); 1♀, 20°58'S, 165°17'E, Pic d'Amoa, summit, 600m, 26.xi.2003, G.B. Monteith, pyrethrum, trees & logs, [11436] (AM); NEW CALEDONIA, PROVINCE SUD: 3♂ 4♀, 22°19'S, 166°55'E, Forêt Nord, Site 1, 480m, 9.i.2005, G.B. Monteith, beating cut branches of *Podocarpus* sp. FN1/2, [12080] (AM & QM); 2♂♀, same data but beating cut branches of Cunoniaceae FN1/3, [12081] (QM); 1♂1♀, same data but beating cut branches of *Styphelia* FN1/1, [12079] (AM); 2♂4♀, same locality, 22.xii.2004 - 9.i.2005, Burwell & Wright, malaise trap, rainforest, [12074] (AM & QM); 1♀, same locality, 2-3.xii.2004, C.J. Burwell & G.B. Monteith, pyrethrum, [11822] (QM); 1♂, 22°17'S, 166°53'E, Pic du Grand Kaori, Site 2, 250m, 21.xii.2004 - 12.i.2005, Wright & Burwell, malaise trap, rainforest, [12030] (AM); 2♂, 22°17'S, 166°53'E, Pic du Grand Kaori, Site 1, 250m, 22.xii.2004 - 12.i.2005, Burwell & Wright, malaise trap, rainforest, [12020] (AM); 1♀, 22°14'S, 166°50'E, Pic du Pin, Site 2, 280m, 12.i.2005, G.B. Monteith, beating cut branches of PP2/3, [12054] (QM). (Numbers within square brackets are collection sample codes used by the Queensland Museum).

DIAGNOSIS. This species is recognised by the following characters: tricoloured body, mostly orange-brown with white and red markings (Fig. 1); A1 narrowly vasiform, longer than interocular distance (Fig. 1); A11 banded (Fig. 1); A111 very short (Fig. 1); fourth labial segment very short; metafemora banded (Fig. 1); and, female abdominal venter with lateral red markings.

DESCRIPTION. Colouration (Fig. 1): Body tricoloured, ground colour yellow to orange-brown, with white and red to reddish brown markings. Head, mostly pale orange-brown, sometimes with red highlighting; bucculae and labrum mostly red. Labium: L1 red; L11-L14 orange-brown. Antennae: A1 orange-brown; A11 proximal two fifths orange-brown, medially dark reddish brown, and tip with white annulation; A111 and A114 dark reddish brown. Pronotum: collar pale red; callosite region white; disc pale red, often darker

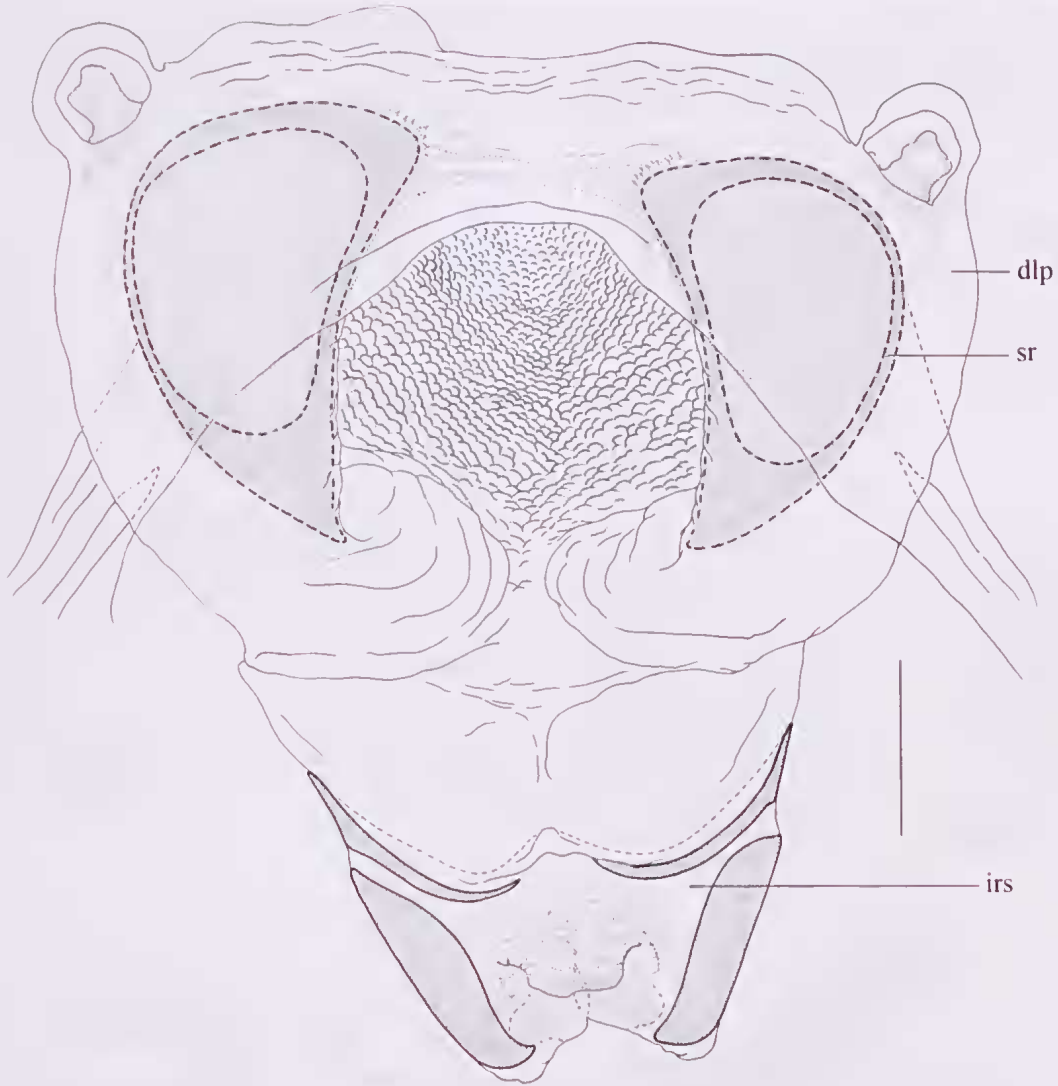


FIG. 4. *Kanakamiris krypton* gen. et sp. nov., female genitalia. Abbreviations: dlp, dorsal labiate plate; irs, interramal sclerite; sr, sclerotised rings.

laterally. Thoracic pleura: proepisternum white, remainder red. Mesoseutum: red, sometimes with dusty appearance; lateral margins narrowly yellow. Scutellum: tumose medial region mostly yellow, often with dusty highlighting; laterally grey. Hemelytra: clavus proximal $\frac{1}{2}$ mostly red (narrowly white laterally), medially translucent white, distal $\frac{1}{3}$ orange-brown; corium proximally translucent white, broad medial red band, more distally with translucent white band, and apically with broad reddish brown band. Legs: fore and middle legs mostly yellowish brown, sometimes with weak red highlighting; hind femora banded,

mostly pale red, with subapical and apical orange-brown annulations; metatibiae mostly red, basally and apically yellowish brown to orange-brown; tarsi mostly brown, sometimes paler proximally. Abdominal venter: female most often yellowish brown, SVI-XIII with lateral dark reddish brown marking, sometimes with broad red infuscation; male pregenital abdominal venter orange-brown with red to dark reddish brown highlighting, pygophore mostly orange-brown, with ventral region adjacent to genital opening fuscous.

Vestiture. Dorsum with moderately dense covering of simple, decumbent to erect setae, paler and

TABLE 1. Measurements of external characters of males and females of *Kanakamiris krypton*. Abbreviations: BL, body length; C-CL, clypeal to cuneal length; HL, head length; PL, pronotal length; CL, cuneal length; HW, head width; PW, pronotum width; SW, scutellum width; IOD, interocular distance; AI, first antennal segment length; AII, second antennal segment length; AIII, third antennal segment length; and, AIV, fourth antennal segment length.

	BL	C-CL	HL	PL	SL	CL	HW	PW	SW	IOD	AI	AII	AIII	AIV
Males														
Mean	4.05	2.87	0.29	0.62	0.47	0.51	0.67	1.07	0.42	0.29	0.64	1.27	0.41	0.78
Standard Deviation	0.05	0.18	0.07	0.05	0.04	0.04	0.02	0.12	0.00	0.02	0.06	0.14	0.08	0.12
Range	0.09	0.32	0.13	0.09	0.09	0.07	0.04	0.24	0.01	0.04	0.11	0.25	0.15	0.25
Minimum	3.99	2.66	0.23	0.58	0.44	0.48	0.65	0.95	0.42	0.27	0.60	1.19	0.32	0.65
Maximum	4.08	2.99	0.36	0.68	0.52	0.55	0.69	1.19	0.43	0.31	0.71	1.44	0.47	0.89
n	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Females														
Mean	4.50	3.46	0.38	0.70	0.49	0.51	0.71	1.17	0.45	0.24	0.72	1.39	0.56	0.96
Standard Deviation	0.26	0.21	0.06	0.03	0.05	0.06	0.03	0.06	0.04	0.03	0.07	0.10	0.09	0.31
Range	0.68	0.50	0.15	0.07	0.12	0.14	0.07	0.13	0.11	0.07	0.16	0.26	0.21	0.63
Minimum	4.14	3.16	0.30	0.67	0.42	0.42	0.68	1.11	0.39	0.21	0.62	1.28	0.43	0.67
Maximum	4.82	3.66	0.45	0.74	0.55	0.56	0.74	1.24	0.50	0.28	0.78	1.54	0.64	1.30
n	5	5	5	5	5	5	5	5	5	5	5	5	4	5

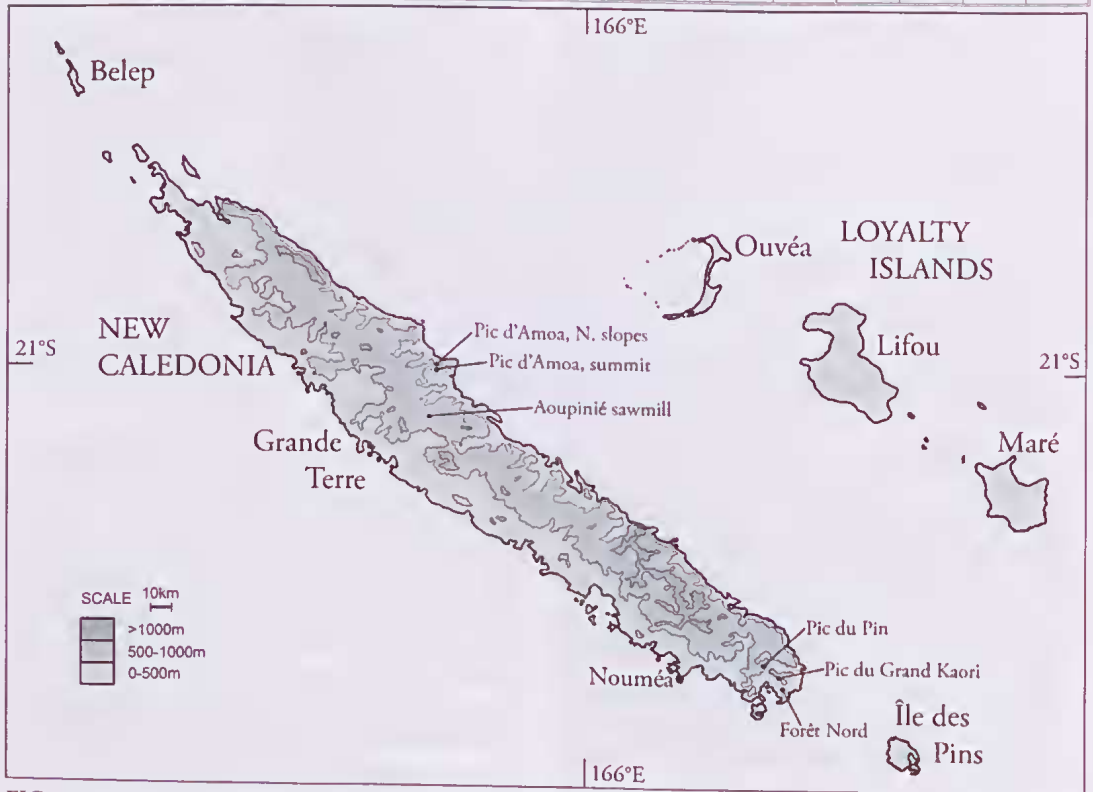


FIG. 5. Map of New Caledonia showing records of *Kanakamiris krypton*.

TABLE 2. Characters and character states of the *Vannius* complex and outgroups.

1. Head orientation: horizontal (0); dorsoventral (1); ventral (2).
2. Frons and clypeus: bilobed (0); coplanar (1).
3. Vertex sulcation: absent (0); present (1).
4. Antennal shape: not thread-like (0); threadlike (1).
5. Antennal segment I: shorter or subequal to head length (0); significantly longer than head length (1).
6. Pronotal collar: absent (0); present (1).
7. Disruptive colouration: absent (0); present (1).
8. Metafemora: moderately elongate (0); greatly elongate (1).
9. Pretarsal claw subapical teeth: absent (0); one pair (1); two pair (2).
10. Parempodia: setiform (0); spatulate (1).
11. Left paramere size: elongate (0); short (1).
12. Aedeagus shape: broad (0); narrow (1).
13. Secondary gonopore: undifferentiated (0); simple aperture (1); ring-like aperture (2).
14. Secondary gonopore: proximal (0); distal (1).
15. Endosomal apex: not serrate (0); serrate (1).
16. Sclerotised rings: thin (0); thick (1).
17. Ventral labiate plate: separated medially (0); joined anteriorly (1).
18. Dorsal labiate plate: not expanded lateral of sclerotised rings (0); expanded lateral of sclerotised rings, lateral-most margins scroll-like (1).
19. Inter-ramal sclerite: divided, with two thin sclerites (0); spanning base of first valvifer (1).
20. Inter-ramal lobes: absent (0); present (1).

LII; LIV very short. Male and female genitalia as in generic description.

MEASUREMENTS. See Table 1.

DISTRIBUTION (FIG. 5). All six collection localities are in high-rainfall rainforest areas at medium altitudes from 250 to 600m. The localities fall into two disjunct groups, three at the southern extremity of the Grande Terre, and three clustered about 200km further north in the northern half of the island. This apparent pronounced disjunction may be genuine because the Queensland Museum has sampled, using similar methods at more than 200 localities throughout the island. Many of the negative localities are similar in vegetation and altitude (Col d'Amieu, Monts des Koghis, Mandjélia) and have been sampled much more intensively. All positive localities lie within nature reserves.

REMARKS. *Kanakamiris krypton* is highly autapomorphic, differing from other species of the *Vannius* complex in possessing a platelike labrum. Its disruptive colouration is unlike *Austrovannius* species, and more like all the other genera of the *Vannius* complex in possessing broad rectangular red markings on the dorsum. The very short third antennal segment of *K. krypton* is unlike other species of the *Vannius* complex, and is a strong diagnostic marker.

TABLE 3. Character matrix of three outgroups (*Bothriomiris lugubris*, *Peritropisca bituberculata* and *Cylapocerus* sp.) and six genera of the *Vannius* complex and eleven characters. Missing data = ?

Character #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
<i>Bothriomiris</i>	0	0	0	0	0	0	0	0	0	?	0	0	0	?	0	?	?	1	1	0
<i>Peritropisca</i>	0	0	1	0	0	0	0	0	0	0	0	0	0	?	0	?	?	0	0	1
<i>Cylapocerus</i>	1	1	1	0	0	0	0	?	0	0	0	0	1	0	0	?	?	?	?	1
<i>Afrovannius</i>	2	1	1	1	0	1	1	1	2	1	1	0	1	0	0	?	?	?	?	?
<i>Austrovannius</i>	0	1	1	1	1	1	1	0	1	1	0	0	2	0	1	0	0	1	1	1
<i>Kanakamiris</i>	0	1	1	1	1	1	1	0	1	1	0	0	2	0	1	0	0	1	1	1
<i>Paracylapus</i>	2	1	1	1	0	1	1	1	2	1	1	0	1	0	0	?	?	?	?	?
<i>Vanniopsis</i>	0	1	1	1	1	1	1	1	1	1	0	0	1	?	0	0	1	0	0	0
<i>Vannius</i>	2	1	1	1	0	1	1	0	1	1	0	1	1	1	0	?	?	?	?	?
<i>Vanniusoides</i>	2	1	0	0	1	1	1	1	1	1	0	1	1	1	1	0	1	0	0	0

PHYLOGENETICS

The phylogeny of the genera of the *Vannius* complex presented here is based on an analysis of 20 morphological characters. The characters and character states are given in Table 2 and the data matrix in Table 3. A single tree was found, of the same topology and tree length (34 steps) for the unweighted, successive weighting and implied weights analyses. The tree statistics are as follows: consistency index of 0.68 and retention index of 0.70, and all nodes have a bootstrap value equal to or above 66%.

The cladogram is given in Fig. 6. Its topology differs substantially from that presented by Cassis et al. (2003). *Vanniopsis* is now more basal to the Afrotropical (*Afrovannius* and *Paracyclapus*) and Neotropical (*Vannius*) genera, and no longer sister to *Vanninoides* which is now sister-taxon to *Vannius*. In both trees, *Austrovannius* is the most basal taxon, but now is also sister to the new genus *Kanakamiris*.

The monophyly of the *Vannius* complex is supported by a 98% bootstrap value and three synapomorphies: pronotal collar present (6-1); disruptive colouration (7-1) and spatulate parempodia (10-1). Cassis et al. (2003) provided additional support in terms of the coplanar frons + elypeus and clongate metafemora, but the former character state is true of other members of the Cylapini, and the latter character is variable within the ingroup. The spatulate parempodia appears to be the most reliable synapomorphy for the group.

The *Austrovannius* + *Kanakamiris* clade is supported by a single synapomorphy (ring-like secondary gonopore; 13-2) and a homoplasy (presence of inter-ramal lobes, 20-1). Clearly, these two genera are not relatives, with *Austrovannius* greatly reduced and highly autapomorphic (pinched ventral margin of pygophore, tarsal claws without subapical teeth, and complex male aedeagus). Likewise, *Kanakamiris* is very distinctive, particularly in relation to the correct head, bicompressed labrum and gula, and inerrassate scutellum. However, the sister-taxon relationship of these sympatric genera is supported by sufficient data and moderately high bootstrap support (74%).

The monophyly of the remaining genera of the *Vannius* complex (*(Vanniopsis + ((Vanninoides + Vannius) + (Afrovannius + Paracyclapus))*) is supported by a high bootstrap value (82%) and two homoplasies, viz. greatly elongate metafemora

(8-1) and the divided inter-ramal sclerite (19-0). Within this clade *Vannius* also has relatively smaller metafemora, although this character system requires closer examination across all the species in the *Vannius* complex. The same is true of the shape of the inter-ramal sclerite, which has not been examined in *Afrovannius*, *Paracyclapus* and *Vannius*.

The *((Vanninoides + Vannius) + (Afrovannius + Paracyclapus))* clade is supported by the lowest bootstrap value (66%) and a single synapomorphy (ventrally oriented head; 1-2). The Afrotropical genera *Afrovannius* + *Paracyclapus* form a strongly supported clade, with high bootstrap value (85%) and two synapomorphies (pretarsal claws with two pairs of subapical teeth, 9-2, and the short left paramere, 11-1). The *Vannius* + *Vanninoides* clade is also robust, with a high bootstrap value (83%) and two synapomorphies (narrow aedeagus, 12-1; secondary gonopore distal, 14-1).

BIOLOGY

Some information about the biology of *K. krypton* can be derived from the collecting methods and label data. Most (26) of the 34 specimens were taken during the course of an intensive insect survey of 8 rainforest sites at the southern end of the island in the summer (Nov to Jan) of 2004–2005 (Monteith et al., 2006). A range of 14 collecting methods was used at each site in a standard manner during the survey. The site where the mirids were commonest (15) was the 480m summit of Forêt Nord (Fig. 7A), which was the wettest site surveyed, with cloud often persistent. The only methods that yielded *K. krypton* specimens were, in order of success: beating cut branch traps (16), malaise trap (9) and pyrethrum spraying of tree trunks (1). None were collected by other methods such as light traps, leaf litter extracts, sweeping and beating foliage, all of which yield other species of Miridae.

'Cut branch traps' were made from batches of freshly cut, leafy branches, tied up into tight bundles with wire, and hung in the forest to wilt and decay in the natural weather. Each bundle comprised branches of only one tree species and three different species were hung at each site. The object of these traps is to collect beetles, such as longicorns and weevils, which come to dying vegetation. The traps were set in early December (end of the dry season) and were sampled by beating (Fig. 7B) about every week



FIG. 7. A, Interior of rainforest at summit of Forêt Nord. B, Beating a cut branch trap to collect *Kanakamiris krypton*. Photographs by Jeff Wright, QM.

until mid-January, after the summer rains had started. No *Kanakamiris* were taken during the December samplings, when the leaves were dry and withered. But in January, after the rains had started, the leaf bundles had a strong smell of mouldy decay and, in the centre, the leaves were black with mildew. At the Forêt Nord site, every bundle produced large numbers of the bugs, though few were collected because they ran and flew with great agility when they fell to the beating sheet. Clearly there was no association with a particular plant species because the leaf bundles comprised a gymnosperm (*Podocarpus* sp.) and angiosperms of two contrasting families, Epacridaceae (*Styphelia* sp.) and Cunoniaceae.

The only other method to catch significant numbers were malaise traps, which trap insects dispersing by flight through the lower storey of the forest. We believe this sampling evidence supports the view that *Kanakamiris* are mycetophages which fly through the forest in search of fallen, mouldy leafy branches, which are a common occurrence in rainforests during the stormy wet

season. This augments other published evidence (see introduction) that Cylapini (including the *Vannius* complex) are primarily fungal feeders. The possibility that they feed on other mycetophagous insects also needs to be tested.

DISCUSSION

The basal sister-group relationship of the New Caledonian genera *Austrovannius* and *Kanakamiris* established in this work, suggests a biogeographically significant relictual distribution. As suggested by others, New Caledonia has a disproportionate number of basal taxa, both plant and animal, which are indicative of relict (Jaffré et al. 2001; Edgecombe 2003). Within the *Vannius* complex, the abovementioned genera are clearly differentiated from all others of the suprageneric group, particularly by the ring-like secondary gonopore. The more 'up-tree' genus *Vanniopsis* is also found in New Caledonia, with the type species, *V. rufescens* Poppius found in New Caledonia as well as Vanuatu, the latter a place of more recent biogeographic

connections (Raven & Axelrod 1972). In this work, *Vanniopsis* is established as the sister-taxon to *Vanniusoides* + *Vannius*, with both of the former genera having continental Australia + Melanesian distributions (Cassis et al., 2003). On the basis of this analysis, the presence of *Vanniopsis* in New Caledonia, however results in significant biogeographic paralogy, such that ambiguity exists as to whether New Caledonia is basal to other circumtropical regions of the world.

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LITERATURE CITED

- BOLTE, K.B. 1996. Techniques for obtaining scanning electron micrographs of minute arthropods. *Proceedings of the Entomological Society of Ontario* 127: 67-87.
- CASSIS, G. 1995. A reclassification and phylogeny of the Termatophylini (Heteroptera: Miridae: Deraeocorinae), with a taxonomic revision of the Australian species, and a review of the tribal classification of the Deraeocorinae. *Proceedings of the Entomological Society of Washington* 97(2): 258-330.
- CASSIS, G. & GROSS, G.F. 1995. Hemiptera: Heteroptera (Coleorrhyncha to Cimicomorpha). *Zoological Catalogue of Australia*. Volume 27.3A. i-xv, 506 pp (CSIRO Publishing: Melbourne).
- CASSIS, G., SCHWARTZ, M.D. & MOULDS, T. 2003. Systematics and new taxa of the *Vannius* complex (Hemiptera: Miridae: Cylapinae) from the Australian Region. *Memoirs of the Queensland Museum* 49: 125-143.
- DISTANT, W.L. 1920. Rhynchota from New Caledonia. *Annals and Magazine of Natural History* (9)6:143-164.
- DONALDSON, J.F. 1988. Further studies on Asiraeninae (Homoptera: Delphacidae) in Australia and New Caledonia. *Journal of the Australian Entomological Society* 27:133-141.
- EDGEcombe, G.D. 2003. A new genus of hemicopid eentipede (Chilopoda: Lithobiomorpha) from New Caledonia. *Memoirs of the Queensland Museum* 49(1): 269-284.
- EVANS, J.W. 1982. A review of present knowledge of the family Peloridiidae and new genera and new species from New Zealand and New Caledonia (Hemiptera: Insecta). *Records of the Australian Museum* 34: 381-406.
- GORCZYCA, J. 2000. A systematic study on Cylapinae with a revision of the Afrotropical Region (Heteroptera, Miridae). *Wydawnictwo Uniwersytetu Slaskiego, Katowice* 2000: 1-174.
- HAMILTON, A. 1999. The ground-dwelling leafhoppers Myerslopiidae, new family, and Sagmatiini, new tribe (Homoptera: Membracidae). *Invertebrate Taxonomy* 13:207-235.
- JAFFRÉ, T., BOUCHET, P.H., VEILLON, J.-M., RIGAU, F. & DAGOSTINI, G. 2001. Composition and characterization of the native flora of New Caledonia. *IRD Documents Scientifiques et Techniques* (2)4: 1-121.
- KERZHNER, I.M. & KONSTANTINOV, F.V. 1999. Structure of the aedeagus in Miridae (Heteroptera) and its bearing to suprageneric classification. *Acta Societas Zoologicae Bohemicae* 63: 117-137.
- MADDISON, W.P. & MADDISON, W.R. 2001. *MacClade 4. Analysis of Phylogeny and Character Evolution*. Version 3. Sunderland: Sinauer Associates (Version 4.02).
- MITTERMEIER, R.A., GIL, P.R., HOFFMAN, M., PILGRIM, J., BROOKS, T., MITTERMEIER, C.G., LAMOREUX, J. & DA FONSECA, G.A.B. 2004. *Hotspots revisited*. Washington DC: Cemex.
- MONTEITH, G.B. 1980. Relationships of the genera of Chinamyersiinae, with description of a relict species from north Queensland (Hemiptera: Heteroptera: Aradidae). *Pacific Insects* 21(4): 275-285.
- MONTEITH, G.B., BURWELL, C.J. & WRIGHT, S.G. 2005. *Inventaire de l'entomofaune de la forêt humide de quatre réserves spéciales botaniques du Grand Sud de la Nouvelle Calédonie*. Report to Direction des Ressources naturelles, Province Sud. 136 pp. (Queensland Museum, Brisbane).
- RAVEN, P.H. & AXELROD, D.I. 1972. Plate tectonics and Australasian biogeography. *Science, New York* 176: 1379-1386.
- SCHUH, R.T. 1975. The structure, distribution and taxonomic importance of trichobothria in the Miridae (Hemiptera). *American Museum Novitates* 2585: 1-26.
1976. Pretarsal structure in the Miridae (Hemiptera) with a cladistic analysis of relationships within the family. *American Museum Novitates* 2601: 1-39.

1986. *Schizopteromiris*, a new genus and four new species of coleopteroid eulapine Miridae from the Australian Region (Heteroptera). *Annales de la Société Entomologique de France* (N.S.) 22(2):241-246.
- SCHUH, R.T. & SLATER, J.A. 1995. True Bugs of the World (Hemiptera: Heteroptera). Classification and Natural History. i-xii, 336pp (Cornell University Press, Ithaca, New York).
- ŠTYS, P. 1981. A new relict subfamily, genus and species of Enieocephalidae from New Caledonia (Heteroptera). *Acta Entomologica Bohemoslavaca* 78:412-429.
- SWEARINGEN, M., HEADRICK, D. & BELLOWS, T. 1997. Comparison of fixation and drying procedures for scanning electron microscopy among insect body types. *Proceedings of the Entomological Society of Washington* 99(3): 513-522.
- SWOFFORD, D.L. 2002. PAUP*. Phylogenetic Analysis Using Parsimony (*and other methods). Version 4.0b10. (Sinauer Associates: Sunderland).
- WHEELER, A.G. 2000. Biology of the Plant Bugs (Hemiptera: Miridae). Pests, Predators, Opportunists. (Cornell University Press: Ithaca).